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None

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(54) Connector with impedance-matched switch

(57) A cross-connector for allowing alternative connection of co-axial circuits without interruption of signal, includes a first (2), second (3) and third (4) co-axial connector and a make-before-break switch (40) between them to make electrical contact between a first pairing (3, 2) of the connectors before breaking electrical contact between a second pairing (3, 4) of the connectors, the switch (40) being of a geometry to provide impedance characteristics matching those of the connectors. The switch may include at least one conductor (43, 44) which is in part surrounded by a dielectric (41). The switch may be operated by movement of the central conductor (16) of connector (3).

Fig.1.

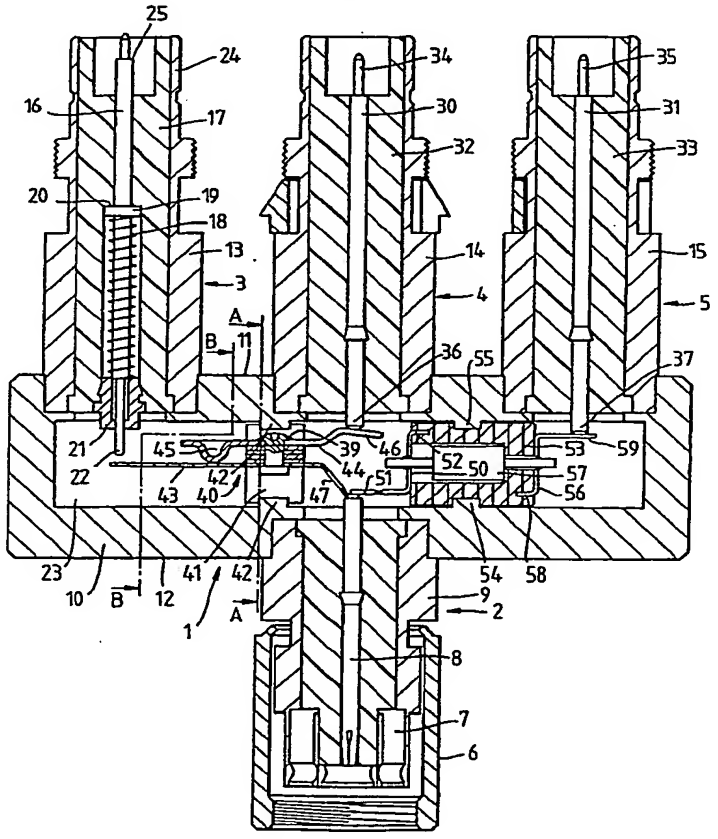

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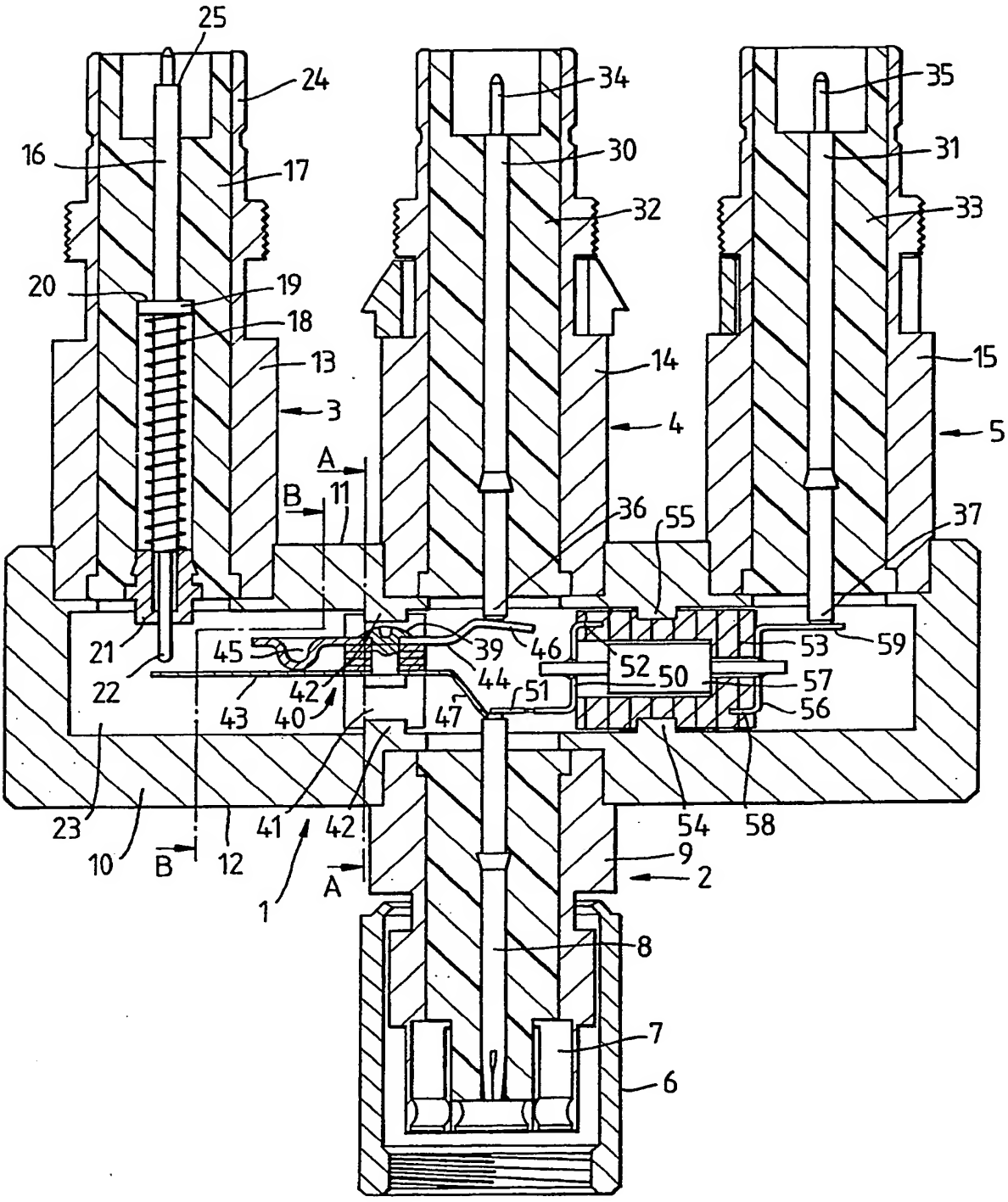
Fig.1.



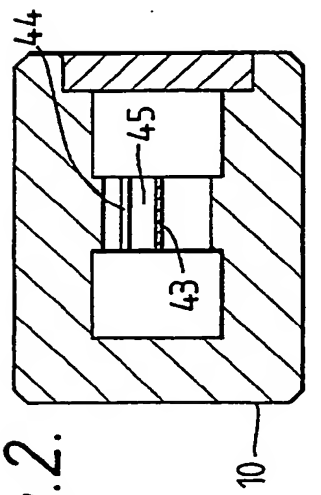


Fig.2.

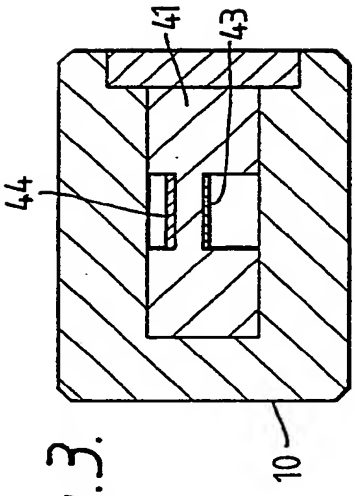


Fig.3.

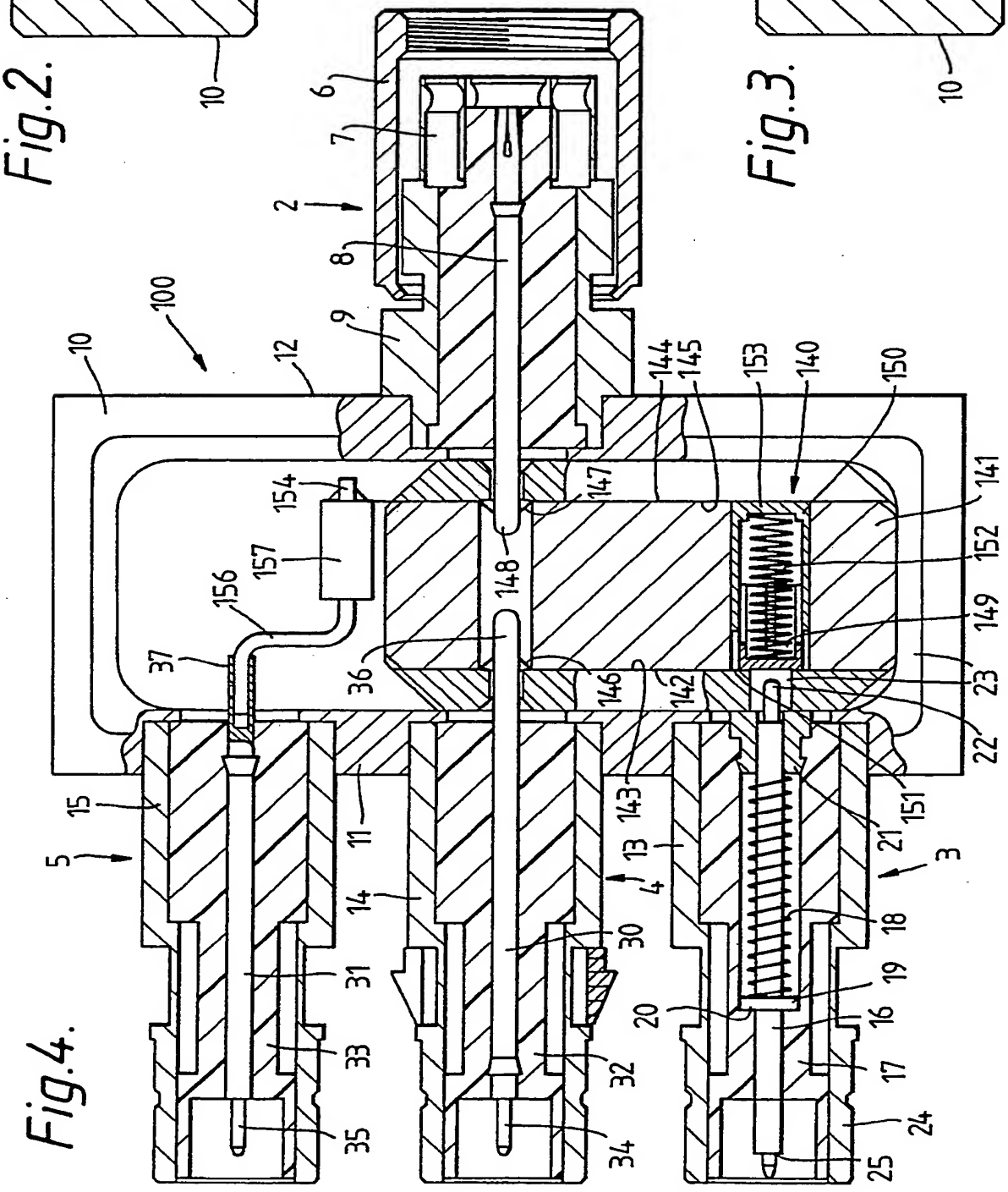


Fig.4.

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CROSS-CONNECTOR WITH CO-AXIAL CHARACTERISTICS

This invention relates to a cross-connector. This is a device for allowing the temporary re-routing (commonly known as "cross-connect") of communication paths through a telephone exchange or the like, as is needed when the normally-used line is required for maintenance operation.

It is an object of the present invention to provide a cross-connector which entirely eliminates down-time.

For this purpose we use a "make-before-break" switch.

Such switches are known per se, and in EP-A-380210 there is disclosure of a make-before-break switch in a cross-connector.

However, the switch proposed there is mechanically extremely complex and also requires electrical complexity, which has been provided in an attempt to make the impedance of the switch mimic that of the coaxial conductors which are connected through the cross-connector.

The present invention provides a cross-connector in which a truly nominal characteristic impedance is preserved throughout, while remaining extremely simple mechanically and electrically.

According to the present invention there is provided a cross-connector for allowing alternative

connection of coaxial circuits without interruption of signal which includes a first, a second and a third coaxial connector, and a switch between them to make contact between one pairing of the connectors before breaking a contact between another pairing of the connectors, the switch being actuated by a temporary connection made to one of the connectors, and being in a housing of the cross-connector and having conductors disposed in that housing so as to provide impedance characteristics matching those of the connectors.

The cross-connector may be one in which the switch is actuated by a centre conductor of one of the connectors upon a connection being made to that connector - see our co-pending UK Application 9201263.3. It is advantageous though not essential to have in the cross-connector a fourth coaxial connector which is in permanent communication with both of the pairings of the first, second and third connectors, through an attenuator to provide e.g. a nominal -30dB test access.

Normally the switch will have a coaxial characteristic not by virtue of being truly coaxial in the sense of a line conductor within a cylindrical sheath, but by being a strip-line (i.e. in effect a "flat coaxial" conformation) in which preferably the outer conductive sheath defines a rectangular cross-sectional space around a flat strip conductor.

Embodiments of the present invention are designed to interconnect a series of alternating current or digital signals and in this respect the effects of inductance and capacitance and therefore complex impedance have been carefully considered through the design of the device. Various configurations of coaxial and stripline circuits have been used to ensure impedance matching throughout and the matching of capacitative and inductive reactance in order to ensure current and voltage are maintained in phase to reduce reactive power loss. Attenuation through the cross-connector is also of significant importance, therefore contact resistance at each junction of centre conductors have been kept as low as possible e.g. by the use of gold plating deposits in order that the resistance per unit length of these centre conductors is not increased. The result of these detailed considerations is that when the cross connector is subjected to a return loss measurement through any pair (with the exception of the optional test access) of connected connectors, through a frequency range of 0 to 799 megahertz, the cross connector maintains its characteristic impedance of e.g. 75 ohms within 8% in both switched and unswitched conditions.

A particular embodiment of the invention will now be described with reference to the drawings in which:

Figure 1 is a median section through a first embodiment;

Figures 2 and 3 are sections of the planes A-A and B-B respectively; and

Figure 4 is a median section through a second embodiment.

The cross-connector 1 has a first 2, a second 3, a third 4 and a fourth 5 coaxial connector.

The first connector 2 is for the reception at a conventional coupling 6,7 of a permanent line for connection to its central conductor 8 and outer conductor 9.

The outer conductor 9 of the first connector 2 is housed in and makes electrical contact with a massive conductive housing 10 which is hollow rectangular in both of its cross-sections.

On the major face 11 opposite to that face 12 from which the first connector 2 projects, the outer conductors 13,14 and 15 of the second, third and fourth connectors are respectively connected and project. In this embodiment these second, third and fourth connectors have their central conductors in a single plane and are aligned parallel with each other, the third connector being coaxial with the first. However such a disposition is not essential.

In the second connector 3, the central conductor 16 is slidably borne within its solid dielectric 17, being urged axially outwardly by a spring 18, this movement being stopped by a collar 19 on the conductor abutting against a shelf 20 within the dielectric. At its other end the spring

18 bears against a cap 21 secured within the dielectric, through which an end portion 22, the extreme end of which is rounded, of the central conductor 16 projects into the cuboid space 23 within the housing 10.

Reception arrangements 24 at the free end of the second connector 3 are conventional for reception of a plug on, for example, a patch line, which when so fitted will engage a shoulder 25 on the inner conductor 16 and move the end portion 22 of that inner conductor against the axial urging of the spring 18 inwardly into the space 23 within the housing.

Third and fourth coaxial connectors 4 and 5 are conventional structures which are similar to each other, each having a central conductor respectively 30 and 31, fixedly secured within a dielectric 32,33 and having a free end 34,35 for connection with the inner conductor of a plug respectively fixed to them through conventional connecting arrangements.

At their other ends the conductors 30,31 project by their ends 36,37 respectively into the space 23 within the housing 10.

A make-before-break switch 40 is positioned in the space and has the effect of ensuring either contact between the first and second connectors or contact between the first and third connectors, with contact between either one of those pairings being made before it is broken with the other

of those pairings.

The switch is mounted in a block 41 engaged with projections 42 on the inside walls of the housing 10. A resilient strip 43 and a stronger and less resilient strip 44 are secured together by rivet 39 in the block which is considered as dielectric. Strip 43 is urged by its own resilience into contact with a contact pip 45 on the strip 44, the other end of which is at 46 and is held by its own resilience in permanent contact with the end 36 of the inner conductor 30 of the third connector 4.

One end of the resilient strip 43 lies below the end 22 of the axially movable inner conductor 16 of the second connector 3 while its other end 47 is urged into permanent contact with the inner conductor 8 of the first connector 2.

Also in permanent contact with the inner conductor 8 of the first connector 2 is a second resilient strip 50, which presses by its end 51 on the strip 47. This strip 50 is anchored by one end 52 to a block 53 which is engaged within the housing 10 by projections 54,55. Electrical connection between strip 50 and a second strip 56 at the far end of the block 53 is assured through a resistor 57. One end 58 of the strip 56 is anchored in the block 53, the other end 59 being urged by virtue of the resilience of the strip permanently into contact with the end 37 of the inner conductor 31 of the fourth connector 5.

The conformation of the strip 43 in relation to the size and shape of the space 23 of the housing 10 is such that that strip offers an impedance which matches that of the coaxial connectors between which it forms a contact. The conformation for achieving a known characteristic impedance in this configuration (known as a "strip-line") are well-known to those in the art.

In the present instance the desired impedance is 75 ohm since the coaxial connectors which are particularly intended here are 75 ohm SMB connectors.

Figure 2 shows the stripline configuration at its most complex point. This configuration has been generally assumed to be a shielded suspended substrate broadside coupled stripline where the material used to support the central conductors is considered as the dielectric for the complete configuration. Figure 3 shows the stripline configuration close to the point contact of the axially movable inner conductor 16. This configuration generally resembles an off centre stripline where at this section the central conductor is considered to be in an air dielectric.

In use, the cross-connector is left permanently connected with a socket on a coaxial cable through the third connector 4, and the selected line is then normally in electrically conductive relation with the first connector 2 via strip 44, pip 45 and strip 43. A plug on the first connector 2 will form a permanent connection with that.

However if the line permanently connected to the third connector 4 is desired to be taken out of use, for example for maintenance, a temporary line, for example a patch line terminating in a plug, is connected to the replacement line and the plug is brought to the connection portion 24 of the second connector 3. As the plug is pushed onto that connector the inner conductor 16 is pushed axially inwardly and comes into contact by means of its end 22 with the strip 43. As axial movement continues that contact will cause flexion of the strip 43 around its anchor point at the rivet 39 and eventually a break in conduction between the pip 45 and the strip 43. The circuit is now assured between the plug connected to the first connector 2 to the temporary line connected to the second connector 3.

Since the impedance of the switch 40 in either of its conditions is matched to the impedance of all three connectors the loss suffered on the line is minimal, and since the switch is a make-before-break switch there is no down-time at all.

A second embodiment of the invention will now be described with reference to Figure 4.

As in the first embodiment, the cross-connector 100 has a first 2, a second 3, a third 4, and a fourth 5 coaxial connector.

The first connector 2 is for the reception at a conventional coupling 6,7 of a permanent line for connection

to its central conductor 8 and outer conductor 9.

The outer conductor 9 of the first connector 2 is housed in and makes electrical contact with a massive conductive housing 10 which is hollow rectangular in both of its cross-sections.

On the major face 11 opposite to that face 12 from which the first connector 2 projects, the outer conductors 13,14 and 15 of the second and third and fourth connectors are respectively connected and project. In this embodiment these second, third and fourth connectors have their central conductors in a single plane and are aligned parallel with each other, the third connector being coaxial with the first. However such a disposition is not essential.

In the second connector 3, the central conductor 16 is slidably borne within its solid dielectric 17, being urged axially outwardly by a spring 18, this movement being stopped by a collar 19 on the conductor abutting against a shelf 20 within the dielectric. At its other end the spring 18 bears against a cap 21 secured within the dielectric, through which an end portion 22, the extreme end of which is rounded, of the central conductor 16 projects into the cuboid space 23 within the housing 10.

Reception arrangements 24 at the free end of the second connector 3 are conventional for reception of a plug on, for example, a patch line, which when so fitted will engage a shoulder 25 on the inner conductor 16 and move the

end portion 22 of that inner conductor against the axial urging of the spring 18 inwardly into the space 23 within the housing.

Third and fourth coaxial connectors 4 and 5 are conventional structures which are similar to each other, each having a central conductor respectively 30 and 31, fixedly secured within a dielectric 32,33 and having a free end 34,35 for connection with the inner conductor of a plug respectively fixed to them through conventional connecting arrangements.

At their other ends the conductors 30,31 project by their ends 36,37 respectively into the space 23 within the housing 10.

A make-before-break switch is positioned in the space and has the effect of ensuring either contact between the first and second connectors or contact between the first and third connectors, with contact between either one of those pairings being made before it is broken with the other of those pairings.

In the present embodiment the switch 140 is mounted in a non-conducting block 141 located inside the housing 10. A first planar conductor 142 is mounted on a face 143 of the block 141 nearest to the major face 11 of the housing 10, and a second planar conductor 144 is mounted on the opposite side of the block 141, on a face 145 nearest the face 12 of the housing. A portion 146 of the conductor

142 has radial slits so that the material of the conductor may be distorted by and grip onto the end 36 of the inner conductor 30 and thereby assure electrical contact, and similarly a portion 147 of the conductor 144 grips and contacts an end 148 of the inner conductor 8.

A rider 149, made of electrically conductive material, is adapted to move in a cup 150, also made of electrically conductive material, which is mounted in the block 141. The rider 149 is urged by a metal spring 152 into contact with the margin of an aperture 151 of the conductor 142, aligned with the end 22 of the conductor 16. A portion 153 of the conductor 144 is in permanent electrical contact with the cup 150 due to urging of this latter by the spring 152.

Also in permanent contact with the conductor 144 is a strip 154. Electrical connection between strip 154 and a second strip 156 connected to the end 37 of the conductor 31 is assured through a resistor 157 e.g. a 2.4 kohm resistor.

The conformation of the connectors 142,144 in relation to the size and shape of the space 23 of the housing 10 is such that those conductors offer an impedance which matches that of the coaxial connectors between which it forms a contact. The conformation for achieving a known characteristic impedance in this configuration (known as a "strip-line") are well-known to those in the art.

In the present instance the desired impedance is 75 ohm since the coaxial connectors which are particularly intended here are 75 ohm SMB connectors.

In use, the cross-connector is left permanently connected with a socket on a coaxial cable through the third connector 4, and the selected line is then normally in electrically conductive relation with the first connector 2 via connector 142, rider 149, cup 150 and connector 144. A plug on the first connector 2 will form a permanent connection with that.

However if the line permanently connected to the third connector 4 is desired to be taken out of use, for example for maintenance, a temporary line, for example a patch line terminating in a plug, is connected to the replacement line and the plug is brought to the connection portion 24 of the second connector 3. As the plug is pushed onto that connector the inner conductor 16 is pushed axially inwardly and comes into contact by means of its end 22 with the rider 149 thus establishing also connection between the first and second connectors. As axial movement continues that contact will cause movement of the rider 149 against the bias of the spring 152 and into the cup 150. Thus contact will be broken between the rider 149 and the margins of the aperture 151 of the conductor 142. The circuit remains assured between the plug connected to the first connector 2 to the temporary line connected to the second

connector 3, via rider 149 cup 150 (and spring 152) and conductor 144.

As with the first embodiment the impedance of the switch 140 in either of its conditions is matched to the impedance of all three connectors the loss suffered on the line is minimal, and since the switch is a make-before-break switch there is no down-time at all.

An optional feature of the invention shown in these embodiments is the provision of a fourth connector, in this embodiment connector 5.

This is intended for use in a test circuit and is in permanent connection via strip 56,156, resistor 57,157 and strip 50,154 with whichever circuit is live through the switch 40,140 and the connectors 2,3 and 4.

This fourth connector is provided for test access by providing a signal which is nominally -30db below the input signal. It may also be used for establishing a second line in parallel to that provided at connector 3 when in this instance a termination having a comparable interface is used to mate to connector 3 and switch off the main line.

CLAIMS

1. A cross-connector for allowing alternative connection of co-axial circuits without interruption of signal, including a first, second and third co-axial connector and a make-before-break switch between them to make electrical contact between a first pairing of the connectors before breaking electrical contact between a second pairing of the connectors, the switch being of a geometry to provide impedance characteristics matching those of the connectors.

2. A cross-connector according to claim 1 including a fourth co-axial connector which is electrically connected through an attenuator to the connector which is common to both the first and second pairings of connectors.

3. A cross-connector according to claim 1 or claim 2 wherein the switch includes at least one conductor which is in part surrounded by a dielectric.

4. A cross-connector according to claim 3 wherein the dielectric is air.

5. A cross-connector according to claim 3 wherein the dielectric is a solid dielectric.

6. A cross-connector as herein described with reference to and as illustrated in Figures 1 to 3 of the accompanying drawings.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number
GB 9301149.2

Relevant Technical fields

(i) UK Cl (Edition L) H2E (ECR)

(ii) Int Cl (Edition 5) H01R

Search Examiner
F J FEE

Databases (see over)

(i) UK Patent Office

(ii)

Date of Search
8.4.93

Documents considered relevant following a search in respect of claims 1 TO 6

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
	NONE	

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

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P: Document published on or after the declared priority date but before the filing date of the present application.

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